REMARKS

Claims 13, 14, 16, 17, 19-24 and 26 are pending. Claims 13 and 20 are amended and claims 15 and 18 are canceled. Claims 14, 16, 19, 22-24 and 26 stand withdrawn from further consideration.

Claims 18 was objected to under 37 CFR §1.75(c). Claim 18 has been canceled.

Claims 13, 15, 17 and 21 were rejected under 35 USC §103(a) as being unpatentable over *Shimawaki* (USP 5,903,018) in view of *Tanoue et al.* (USP 5,598,015) further in view of *Mochizuki et al.* (USP 5,481,120). This rejection is respectfully traversed.

The claimed invention has a feature that the base contact layer of a carbon-doped GaAsSb layer or a carbon doped GaInAsSb layer is formed on the base layer of a carbon-doped InGaAs layer or a carbon-doped GaAsSb layer. As discussed in the specification at page 14, lines 10-14, GaAsSb and GaInAsSb can be doped heavily with carbon of about $5x10^{20}cm^{-3}$ concentration, so that the base contact layer to be connected to the base layer is formed of the heavily doped p++ -GaAsSb layer or p++ -GaInAsSb layer, whereby the base region can have a much lower sheet resistance and contact resistance. Thus, according to the above-described feature of the present invention, the base contact layer can greatly reduce a resistance between an intrinsic base region (the region of the base layer immediately below the emitter layer) and the base electrode, even though the base layer does not have a sufficiently low resistance. Accordingly, a greatly reduced

base resistance can be obtained and a higher maximum oscillation frequency f_{max} can be obtained (see e.g., page 11, line 21 through page 12, line 4 of the specification of the present application).

The claimed invention also has a feature that the substrate is formed of InP, the base layer is formed of a carbon-doped InGaAs layer or a carbon-doped GaAsSb layer and the emitter layer is formed of InP. That is, the claimed invention relates to InP/GaInAsSb-based heterojunction bipolar transistor (HBT) formed on the InP substrate. In the InP/GaInAsSb–based HBT, the InP substrate must be used as the substrate in order to lattice-match the HBT layers (including the collector layer, the base layer and the emitter layer) with the substrate. The base contact layer of a carbon-doped GaAsSb layer or a carbon doped GaInAsSb layer can be also epitaxially grown on the base layer of a carbon-doped InGaAs layer or a carbon-doped GaAsSb layer. According to this good crystallinity of the HBT layers can be obtained and excellent performance of HBT can be achieved.

On the other hand, *Shimawaki* discloses the AlGaAs/GaAs-based HBT including the base contact layer of GaAs layer or InGaAs layer formed on the base layer of InGaAs layer. Thus, the base contact layer of *Shimawaki* is clearly different from that of the present invention. *Shimawaki* fails to teach or suggest the base contact layer of a carbon-doped GaAsSb layer or a carbon-doped GaInAsSb layer formed on the base layer of a carbon-doped InGaAs layer or a carbon-doped GaAsSb layer.

Mochizuki et al. discloses in Fig. 6 a AlGaAs/GaAs-based HBT formed on a GaAs substrate including a base contact layer of carbon-doped GaAsSb layer formed on the base layer

of GaAs layer. Thus, the base layer of *Mochizuki et al.* like *Shimawaki,* clearly differs from that of the present invention. *Mochizuki et al.* also fails to teach or suggest the base contact layer of a carbon-doped GaAsSb layer or a carbon-doped GaInAsSb layer formed on the base layer of a carbon-doped InGaAs or a carbon-doped GaAsSb.

Both *Shimawaki* and *Mochizuki et al.* fail to teach or suggest the combinations of the base layer of a carbon-doped InGaAs layer or a carbon-doped GaAsSb layer and the base contact layer of a carbon-doped GaAsSb layer or a carbon-doped GaInAsSb layer. Thus, one of ordinary skill in the art would not form the base contact layer of a carbon-doped GaAsSb layer or a carbon-doped GaInAsSb layer on the base layer of a carbon-doped InGaAs layer or a carbon-doped GaAsSb layer based on the teachings of *Shimawaki* and *Mochizuki et al.*

The Examiner argues that the InP substrate and the InP emitter layer of *Tanoue et al.* may be substituted for the GaAs substrate and the AlGaAs emitter layer of *Shimawaki*, respectively, in order to increase the cutoff frequency of the device by selecting materials that can be used for the same purpose as stated by *Tanoue et al.* However, as described above, *Shimawaki* and *Mochizuki et al.* relate to AlGaAs/GaAs-based HBT formed on a GaAs substrate. In the AlGaAs/GaAs-based HBT, the GaAs substrate must be used as the substrate in order to lattice-match the HBT layers with the substrate for the same reason as described above. One of ordinary skill in the art would never apply the combinations of the materials forming InP/InGaAs-based HBT formed on the InP substrate to the AlGaAs/GaAs-based HBT formed on the GaAs substrate. Thus, one of ordinary skill in the art would not form the substrate and the emitter layer

of AlGaAs/GaAs-based HBT layer of *Shimawaki* or *Mochizuki et al.* from InP as described in *Tanoue et al.*

As described above, *Shimawaki, Tanoue et al.* and *Mochizuki et al.* are clearly different from the present invention and do not provide any motivation for the present invention. Thus, the present invention would have been unobvious to one of ordinary skill in the art even though *Shimawaki, Tanoue et al.* and *Mochizuki et al.* are combined.

Claim 20 was rejected under 35 USC §103(a) as being unpatentable over *Shimawaki* and *Tanoue et al.* in view of *Hashimoto et al.* (USP 5,846,869). This rejection is respectfully traversed.

Hashimoto et al. fails to provide the teachings which *Shimawaki, Tanoue et al.* and *Mochizuki et al.* lacks.

Hashimoto et al. teaches a thermal treatment to eliminate hydrogen termination and/or OH group terminations adhered to the surface of the base layer. The thermal treatment of *Hashimoto et al.* is to modify the surface state of the base layer.

In contrast, in the present invention, the thermal treatment is conducted in order to eliminate hydrogen in the base layer introduced into the base layer during the deposition of the base layer by MOCVD. The thermal treatment of the present invention is to improve the film quality of the base layer. Thus, the thermal treatment of *Hashimoto et al.* is clearly different from the present invention.

It is noted that the Examiner considers the limitation "for eliminating hydrogen" has an intended use limitation. Claim 20 has been amended to avoid this interpretation.

For at least the foregoing reasons, the claimed invention distinguishes over the cited art and defines patentable subject matter. Favorable reconsideration is earnestly solicited.

Should the Examiner deem that any further action by applicants would be desirable to place the application in condition for allowance, the Examiner is encouraged to telephone applicants' undersigned attorney.

If this paper is not timely filed, Applicants respectfully petition for an appropriate extension of time. The fees for such an extension or any other fees that may be due with respect to this paper may be charged to Deposit Account No. 50-2866.

Respectfully submitted,

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